GENERAL DESIGN CRITERIA
SECTION 3-200
HYDROLOGY/DRAINAGE/URBAN RUNOFF

3-200 HYDROLOGY/DRAINAGE/URBAN RUNOFF

3-201 General

This section establishes design criteria and procedures to be followed in the design of storm drain facilities.

3-201.1 **Definitions**

(1) Major Drainage Channel or System - A channel which drains an area in excess of 750 acres (3km2).

(2) Lateral Drainage Channel or System - A channel which drains an area in excess of 100 acres (0.40km2) but less than 750 (3km2) acres and empties into a major channel.

(3) Local Drainage Channel or System - A drainage system which collects local runoff from an area of less than 100 acres (0.40km2) and transports water to a lateral or major system.

(4) Drainage Channel or System - An open or closed conduit, improved or unimproved, designed for the purpose of collecting and transporting storm water runoff in such manner as to protect public and private property.

(5) Drainage Structure - A catch basin, outlet, inlet, headwall, spillway, energy dissipater, junction box, cleanout box, diversion box, etc., in a drainage channel or closed conduit system.

(6) Design Storm - A storm of a magnitude that may be expected to occur once during a specified number of years and resulting in the maximum storm water runoff to be anticipated once during that specified number of years.

(7) Dry Lane - A minimum street width that shall not be inundated at all times during a given design storm.

3-201.2 **General Responsibility for Drainage Facilities -** The developer of a proposed subdivision is required to:

(1) Accept any drainage entering a proposed subdivision and to provide adequate drainage facilities to convey all drainage on the property to discharge into, or connect to, the drainage facility into which the drainage would naturally flow;

(2) Provide on-site storm detention facilities such that the post-development flow rate for a given design storm does not exceed the pre-development flow rate at the outlet of the subdivision;

(3) Provide on-site erosion protection and desilting facilities

(4) Provide bonds for the cost of design and construction of any drainage facilities, including but not limited to off-site easements or facilities, necessary to accomplish these responsibilities.

(5) Provide all graded pads with adequate drainage facilities as approved by the City Engineer.

(6) Submit plans for all private storm drain systems for review and approval by the City Engineer.

3-201.3 **Design Flows**. Storm drain facilities shall be designed to convey design flows as follows:

(1) All major drainage channels shall be designed to discharge a 100-year ultimate storm, without static head;

(2) Lateral channels shall be designed to discharge a 50-year storm without static head at entrances and a 100-year ultimate storm utilizing available head without causing any damage to surrounding property;

(3) Local channels and drainage facilities within street right of ways shall be designed to discharge a 50-year storm utilizing available head without causing any property damage

(4) All storm drainage systems shall be designed so that the combination of the underground storm drain capacity and street overflow without dry-lane limitations shall convey the 100-year storm event without property damage.

(5) Where a sump condition exists and excess runoff has no alternate route, special design shall be required for the protection of property.

(6) At all major intersections (with major, prime or expressways), surface drainage shall be fully intercepted by properly sized inlets. All inlets adjacent to major intersections shall be designed to intercept a 50-year storm event.

3-202 Hydrologic/Drainage/Urban Runoff Reports

Hydrology and/or drainage reports shall be submitted as required per this manual. Reports shall include the following:

3-202.1 A suitable and recent topographic map that shows the following:

(1) On-site drainage maps at a minimum scale of 1"=100' (1cm=10m)

(2) Off-site drainage maps scales may vary depending on the size of the drainage area covered by the map.

(3) Shows appropriate contours on the map for the drainage on-site and extending beyond the subdivision boundary to indicate the drainage pattern.

(4) Indicate the existing basin boundaries and existing drainage facilities.

(5) Show proposed subdivision layout, proposed drainage systems, and proposed basin layout.

(6) Show quantity of flow and time of concentration at each inlet, outlet, interceptor, point of concentration or confluence points.

(7) All drainage area labels, points of concentration labels and system designations shall be shown in the logical order corresponding to the attached calculations.

(8) Indicate all crests, sags and street intersections with flow arrows.

(9) Compare pre-development and post-development flow rates for a given design storm at the outlet(s) of the subdivision.

(10) To mitigate runoff due to development, show on-site regional detention/desilting facilities that act as treatment control structural Best Management Practices (BMPs). Temporary and permanent detention/desilting facilities shall be shown on the plans.

3-202.2 **Report Calculations**

(1) Hydrology studies shall use appropriate methods and show in detail the determination of basin areas, basin flows, time of concentration, and all assumptions and physical data

(2) Hydraulic studies shall show that all conduits, channels and appurtenances are adequate to handle design flows. Studies shall include entrance and exit conditions, head losses, design flows and velocities, critical depth, scouring and silting velocities, energy and hydraulic gradient lines.

(3) Hydraulic studies shall also include a profile plot for all proposed channels showing channel flow line and water surface profile and hydraulic gradient line for the design-year storm event.

(4) Detention basin calculations shall include inflow and outflow hydrographs developed using an acceptable modeling procedure.

(5) Erosion control calculations shall show that silt and debris generation will be contained on-site using proposed measures including desilting and sedimentation basins.

3-203 **Hydrology**

3-203.1 **Previously Approved Reports** - Runoff quantities; as set forth or derived from the report prepared by Lawrence, Fogg, Florer and Smith titled "A Special Study of Storm Drain Facilities" on file in the office of the City Engineer may be used in the design of drainage facilities in Chula Vista. A hydrologic study prepared and approved at General Development Plan (GDP) or Specific Planning Area (SPA) plan may be used as determined by the City Engineer.

3-203.2 For local drainage basins, storm discharge flow may be estimated based on the Rational Method or the Modified Rational Method. For all lateral and major drainage basins the SCS method, U.S. Army Corps of Engineers HEC-1 computer method or other tabular or computer method may be used upon City Engineer approval.

3-203.3 **Rational and Modified Rational Methods**

(1) The rational method equation relates storm rainfall intensity (I), a selected runoff coefficient (C) and drainage area (A) to the peak runoff rate (Q):

$$Q = CIA \text{ (Empirical Units)}$$

where:

Q = Peak runoff in cubic feet per second
C = Runoff coefficient
I = Intensity, inches per hours
A = Drainage basin area in acres

Or

$$Q=0.278CIA \text{ (Metric Units)}$$

where:

Q = Peak runoff in cubic meters per second
C = Runoff coefficient
I = Intensity in millimeters per second
A = Drainage area in square kilometers

(2) Coefficient of Runoff: Consider probable development. Use highest number of the following values:

a)	Paved Surface	0.90
b)	Commercial Area	0.85
c)	Dense Residential (R2, R3)	0.75
d)	Normal Residential (R1)	0.65
e)	Suburban Property (RE)	0.55
f)	Barren Slopes Steep	0.80
g)	Barren Slopes Hilly	0.75
h)	" " Rolling	0.70
i)	" " Flat	0.65
j)	Vegetated Slopes Steep	0.60
k)	" " Hilly	0.55
l)	" " Rolling	0.50
m)	" " Flat	0.45
n)	Farm Land	0.35
o)	Parks, Golf Courses	0.30

NOTES:

Steep =	Steep, rugged terrain with average slopes generally above 30%.
Hilly =	Hilly terrain with average slopes of 10% to 30%.
Rolling =	Rolling terrain with average slopes of 5% to 10%.
Flat =	Relatively flat land, with average slopes of 0% to 5%.
Composite =	Where drainage areas are composed of parts having different runoff characteristics, a weighted coefficient for the total drainage area may be used.

The runoff coefficient for a basin should be a composite coefficient made of the many different runoff coefficients for the sub-areas of the basin per equation:

$$\frac{CA_T = C_1A_1 + C_2A_2 + \ldots CnAn}{n}$$

(3) Time of Concentration (t_c = minutes) is the time required for runoff to flow from the most remote part of the watershed to the outlet point under consideration. With exceptions for limited natural watersheds, the time of concentration shall be calculated as follows:

a) $t_c = t_i + t_f$ where:

t_i = Initial time or overland flow time of concentration, the time required for runoff to flow to the first inlet or to the street gutter

t_f = Travel time of concentration, the time required for runoff to flow within street gutters to inlets, with channels or within storm drain pipes.

b) t_i may be calculated using the following natural watershed flow formula:

$$t_i = 60x\,[(11.9L^3)/H]^{0.385}$$

L = Length of water shed (miles)
H = Difference in elevation from furthermost point to the design point (feet).

If computed t_i is:	Add
Less than 5 Minutes	6 Minutes
5-10 Minutes	5 Minutes
11-15 Minutes	Use 15 Minutes
Greater than 15 Minutes	0 Minutes

NOTE: *Add minutes only when using this formula.*

c) or, t_I may be calculated using the following flow formula for developed areas with overland flow:

$$t_I = \frac{1.8(1.1-C)\sqrt{D}}{\sqrt[3]{S}} \quad \text{(in minutes)}$$

D = Length of watercourse (feet)
S = Slope (percent)
C = Runoff coefficient

d) For limitations in using these formulas, refer to the San Diego County Hydrology Manual.

(4) **Intensity of Rainfall** (I = inches/hr.) – The rainfall intensity (I) can be calculated using the following equation:

$$I = 7.44 P_6 D^{-0.645}$$

P_6 = adjusted 6-hour storm precipitation (If P_6 is not within 45% to 65% of P_{24}, increase or decrease P_6 as necessary to meet this criteria.)

D = duration in minutes (use t_c)

Note: (1) This equation applies only to the 6-hour storm.
(2) The 24-hour isopluvials are available from the County. The 6-hour isopluvials are in Chula Vista Design Standards.

(5) Area of water shed (A = acres), measured using suitable topographic map.

3-203.4 Other recognized hydrologic methods to determine runoff may be used, if substantiated, and approved by the City Engineer.

3-203.5 Whenever 6-hour storm precipitation rates (10, 50 or 100-year) are used to determine rainfall intensity, the Isopluvial Maps of the City of Chula Vista shall be used.

3-204 **Drainage Criteria**

The storm drainage system, consisting of surface and sub-surface facilities, shall be designed of sufficient capacity, without regards to dry-lane requirements, to convey the 100-year storm event without any damage to properties.

3-204.1 **Street System**

(1) For local drainage systems, inlet size and spacing shall be designed to intercept a 50-year storm without exceeding the City dry lane requirements and without causing property damage.

(2) Underground storm drain facilities, pipes and appurtenances shall be designed to discharge a 50-year storm runoff in an open channel flow condition. If offsite conditions create a seal, special pipe and/or joint design may be required for pressure flow.

(3) Dry-lane Requirements – In no case shall flow (Q_{50}) exceed the top of the curb.

a) Expressways, Six-lane Prime Arterials, and Six-lane Major roads shall maintain two driving lanes dry in each direction.

b) Four-lane Major, Class I Collector and Village Entry roads shall maintain a 12-foot dry lane on each side of centerline (or raised median)

c) Class II and Class III Collector, Secondary Village Entry, Promenade and Residential Streets' flow shall not exceed the top of curb

d) Industrial streets' flow shall not exceed the top of curb.

(4) All drainage shall be intercepted and collected at superelevated roadway transition sections where concentrated flows are not permitted to cross travel lanes under the design storm frequency for the street. Median inlets shall be designed and spaced so the lane adjacent to the median (number one lane or fast lane of traffic adjacent to the median) is free from drainage flow for the design storm frequency.

(5) Under no circumstances shall the flow on one side of given street at a set slope exceed the capacity of a 21 foot inlet (20' opening) to intercept 100% of the flow (Q_{50}).

3-204.2 **Storm Drain Facilities** - Specific methods of handling storm drainage are subject to detailed approval of the City Engineer based on currently accepted engineering practices supported by thorough engineering calculations. The following guidelines shall be used for work in the City of Chula Vista.

(1) The following Manning "n" factors are to be used:

a)

Pipe	n	
CMP, fully bituminous coated	0.024	(Not allowed in City maintained system)
CMP, fully asphalt paved	0.018	(Not allowed in City maintained system)
CMP, invert asphalt paved	0.023	(Not allowed in City maintained system)
RCP, All	0.013	
Cast in place	0.014	
PVC, ALL	0.012	

b)

Channel	n
P.C.C., formed, no finish	0.015
P.C.C., trowel finish	0.013
P.C.C., float finish	0.014
Gunite, no finish	0.019

Gunite, trowel finish 0.015

c) "n" factors for other materials or type of construction shall be as approved by the City Engineer.

(2) Public storm drain pipes shall be reinforced concrete pipe (RCP) unless otherwise stated below or approved by the City Engineer. Corrugated metal pipe (CMP) shall not be used unless specifically approved by the City Engineer.

(3) Minimum pipe diameter shall be 18" (46cm), minimum "D" load rating for RCP within the right of way shall be 1500.

(4) Storm drainage must be enclosed within a closed conduit for design runoff within a street right of way or City easement that can be carried in a 42" (107cm) diameter pipe or less.

(5) Minimum grade of storm drains and culverts shall be 0.5%.

(6) Maximum grade for RCP storm drains shall be 40%. PVC pipe may be used for grades greater than 40%.

(7) Maximum cleanout spacing:

a) Pipe diameters equal to or less than 30" (76cm): 300 feet (91m).

b) Pipe diameters greater than 30" (76cm): 800 feet (244m).

c) Storm drains constructed on grades greater than 20% shall use concrete anchors per Regional Standard S-9 at intervals of not more than 40 feet (12m).

(8) **Storm Drain Systems** – Shall be designed to convey runoff flow from inlets to cleanouts to the system outlet. Inlets will not be allowed on any system pipe larger than 18”, unless approved by the City Engineer.

(9) **Pipe Radius/Watertight Pipe**

a) The radius of pipes in curves shall be based on standard or single bevel or double bevel pipe without breaking joints and shall comply with City of San Diego Drainage Design Manual, Table 1-103.7A. Pipe bevel and length shall be shown on plans.

b) The deflection angle at the inlet or cleanout shall be indicated on the plans and shall not be more than 10 degrees, unless special design is provided by the Engineer of Work on the plans.

c) For all storm drains under pressure, where the design HGL is 1-foot above the inside top of pipe elevation, watertight joints shall be used. Watertight joints shall also be used for storm drains constructed on grades of 20% or greater. If watertight, beveled pipe is proposed the Engineer of Work shall submit evidence that the proposed pipe is readily available. Further, the use of pipe collars will not be allowed in-place of manufactured watertight joints.

d) Prior to construction, the contractor shall submit lay out sheets to the City for the following cases:

i) where horizontal and vertical curves are combined;
ii) where beveled pipe lengths other than 4-feet or 8-feet is required to fit the curve.

(10) Easements:

a) Minimum width of storm drain easements shall be equal to the pipe diameter plus ten feet (3m) or a minimum of 15 feet (5m) in width, whichever is greater.

b) Minimum width of easements for improved channels shall be equal to the width of the improved channel plus ten feet (3m), or a minimum of fifteen feet (5m), whichever is greater.

c) Easements for natural channels shall include the inundation line for the design flood.

d) No fences, walls, or other construction shall be authorized within a drainage easement without the specific written approval of the City Engineer. Easement shall not split lot lines without specific written approval of the City Engineer.

e) No structures, poles, wires or other appurtenances shall extend, or pass over, the boundaries of any drainage easement without the specific written approval of the City Engineer.

f) Drainage easements for open channels shall not be included in building lot area calculations but may be included in setback requirements.

(11) **Safety fences or walls** shall be constructed alongside improved channels or as directed by the City Engineer.

(12) **Minimum freeboard** for channels and brow ditches shall be 6 inches (15cm). For supercritical velocities very close to the critical velocity, make the wall heights at least equal to the sequent depth. For curved alignments, add 1.0 foot (0.3m) above the calculated maximum superelevated water surface.

(13) For supercritical velocities very close to the critical velocity, make the wall heights at least equal to the sequent depth. For curved alignments, add 1.0 foot (0.3m) above the calculated maximum.

(14) Inlets and inlet transition shall not be placed within pedestrian crosswalks or driveways.

(15) Provide a minimum of 10 foot (3.0m) curb transition on both sides of inlets unless otherwise approved by the City Engineer.

(16) Grates will not be considered in calculations as capable of receiving any flow of water since they are easily clogged with debris.

(17) Grates shall be capable of being safely crossed by bicycles.

(18) Permanent improved access shall be provided for maintenance of all public drainage facilities.

(19) Where public storm drains outlet across private property or open space drainage facilities shall be designed to meet structural and hydraulic requirements of the City Engineer. Minimum freeboard of 6" to be maintained.

3-204.3 **Runoff Detention Basins**

(1) The rate of inflow to the storage facility (inflow hydrographs) shall be developed using an acceptable hydrologic procedure, and shall be based on the watershed conditions expected to prevail during the anticipated effective life of the structure. Permanent facilities shall assume ultimate development of the contributing areas.

(2) Detention facilities shall be designed to convey a minimum 100-year frequency storm with a minimum 1-foot (0.3m) freeboard and utilizing maximum expected siltation elevation.

(3) The maximum allowable release rate after development shall not exceed pre-development flow rates. The 10, 50, and 100 year storm events shall be analyzed when releasing flows into a natural channel or when requested by the City Engineer.

(4) Adequate energy dissipation features shall be incorporated to reduce outflow velocities to acceptable levels to avoid downstream erosion.

(5) An emergency or overflow spillway shall be provided to pass the design flow if the principal outlets become blocked.

(6) Outlet facilities shall pass all runoff from a 100-year frequency storm event within a reasonable length of time as determined by the City Engineer.

(7) The California Division of Safety of Dams has jurisdiction over detention facilities: a) meeting or exceeding 25 feet (7m) in height and storing 15 acre-feet (18,500 m^3) or more; or b) of any height storing 50 acre-feet (61,700 m^3)or more; or as determined by the State of California.

(8) Embankment slopes shall be planted to provide erosion protection as determined by the City Engineer.

(9) Developer shall be required to maintain detention facilities in accordance with conditions of tentative map approval. A maintenance schedule shall be submitted for approval by the City Engineer prior to City acceptance of permanent facilities.

(10) Drainage structures within basins shall be provided with a reinforced concrete pad for maintenance purposes. The size, shape and location of the pad will be determined/approved by the City Engineer and Deputy Director of Operations.

3-204.4 **Sediment Basins -** Sedimentation basins shall be designed to provide adequate storage of sufficient duration to cause deposition of transported sediment as determined by the City Engineer.

(1) Vegetation shall be planted on all slopes within the subdivision and on the embankments of the basin to avoid erosion.

(2) Elevation marks shall be placed on the outlet riser pipe to monitor sediment levels.

(3) Sedimentation basins shall be maintained per a maintenance plan approved by, or as determined by the City Engineer.

(4) Pipe outlets shall consist of a perforated vertical pipe or box-type riser connected to a horizontal pipe that extends beyond the downstream embankment or that connects to an existing storm drain system.

(5) An emergency spillway shall be provided so that the capacity of the spillway alone will convey the 100-year design flood.

(6) Basins shall be designed to retain the design flood with a minimum 2-foot (0.6m) freeboard.

(7) Desilting basin(s) shall be designed using the standard equation:

$$As = 1.2Q/Vs$$

Where: *As* is the minimum surface area for trapping soil particles of a certain size; *Vs* is the settling velocity of the design particle size chosen; and Q = C x I x A where Q is the discharge rate measured in cubic feet per second; C is the runoff coefficient; I is the average precipitation intensity for the 10-year, 6-hour rain event and A is the disturbed and undisturbed areas draining into the sediment basin in acres. The design particle size shall be the smallest soil grain size determined by wet sieve analysis, or the fine silt sized (0.01mm) particle, whichever is the largest, and the Vs used shall be 100 percent of the calculated settling velocity.

The length is determined by measuring the distance between the inlet and the outlet; the length shall be more than twice the dimension as the width; the depth shall not be less than three feet nor greater than five feet for safety reasons and for maximum efficiency (two feet minimum of settling depth plus the depth needed for sediment storage). The sediment storage volume shall be determined using the "Basic Soil Loss" table (see below) or any other methodology approved by the City Engineer. The basin(s) shall be located on the site where it can be maintained on a year-round basis and shall be maintained on a schedule to retain the two feet minimum of settling depth.

A sediment basin shall have a means for dewatering within 3 to 7 calendar days following a storm event. Sediment basins may be fenced if safety (worker or public) is a concern, or as determined by the City Engineer.

BASIC SOIL LOSS TABLE
(in cubic yards)*

TRACT AREA (acres)	AVERAGE SLOPES					
	2%	5%	8%	10%	12%	15%
10	270	350	370	400	450	500
15	400	420	460	600	675	750
20	540	700	740	800	900	1000
40	1080	1400	1480	1600	1800	2000
80	2160	2800	2960	3200	3600	4000
100	2700	3500	3700	4000	4500	5000
150	4000	4200	4600	6000	6750	7500
200	5400	7000	7400	8000	9000	10000

* ***Engineer shall interpolate the figures listed in the tables as required.***

3-204.5 **Items to be Submitted with Drainage Calculations** - To ensure proper design and to simplify and expedite checking procedures, design calculations and related information are required for all drainage facilities including the following:

(1) Engineer's design calculations

(2) A suitable topographic map, which includes the subdivision and the total drainage basin with the sub-basins delineated and labeled.

(3) Calculations showing the determination of design flow, including all assumptions and physical data.

(4) Calculations showing that all conduits, channels, and appurtenances are adequate for design flows; to include entrance and exit conditions, head losses,

hydraulic jumps, critical depths, scouring and silting velocities, energy line elevation at the entrance, exit, and at each junction, bend, and angle point, and any other items affecting the functioning of the facility.

(5) A profile (to scale) showing the bottom of the channel or pipe, the hydraulic grade line, and the design flow and velocity.

(6) Calculations showing that the requirements for dry lanes will be met.

(7) All assumptions and input file information for computer programs along with a list of abbreviations and symbols used.]

3-205 **Storm Water Quality and Urban Runoff**

Prior to approval of any and all grading, construction, and building permits for the project, the Developer shall demonstrate to the satisfaction of the City Engineer compliance with all of the applicable provisions of the following and any amendments thereto.

(1) The City of Chula Storm Water Management and Discharge Control Ordinance (Chula Vista Municipal Code Section 14.20).

(2) NPDES Municipal Permit No. CAS0108758 (San Diego Regional Water Quality Control Board Order No. 2001-001).

(3) NPDES Construction Permit Co. CAS000002 (State Water Resources Control Board Order No. 99-08-DWQ), including modifications dated April 26, 2001, where applicable.

During project planning and design, the Developer shall incorporate effective construction and post-construction Best Management Practices and provide all necessary studies and reports as determined by the City Engineer demonstrating compliance with the applicable regulations and standards.

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3-200.11/ Eastlake South Greens (Unit 4) Developed Condition Hydrology Map

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